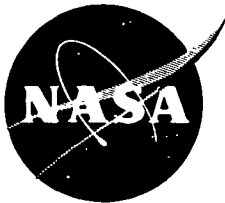


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Annual Report

REMOTE SENSING IN MICHIGAN FOR LAND RESOURCE MANAGEMENT

1 June 1974 Through 31 May 1975

D. S. LOWE, et al.
Infrared and Optics Division

SEPTEMBER 1975

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Mr. Joseph A. Vitale, Technical Monitor



ENVIRONMENTAL

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16. Abstract The Environmental Research Institute of Michigan is conducting a program whose goal is the large-scale adoption, by both public agencies and private interests in Michigan, of NASA earth-resource survey technology as an important aid in the solution of current problems in resource management and environmental protection. During the period from June 1974 to June 1975, remote sensing techniques to aid Michigan government agencies were used to achieve the following results: <ol style="list-style-type: none"> (1) Provide data on Great Lakes beach recession rates to establish shoreline zoning ordinances (2) Supply technical justification for public acquisition of land to establish the St. John's Marshland Recreation Area (3) Establish economical and effective methods for performing a statewide wetlands survey (4) Accomplish a variety of regional resource management actions in the Upper Peninsula, and (5) Demonstrate improved soil survey methods In addition to these major tasks, the project disseminated information on remote sensing technology and provided advice and assistance to a number of users in Michigan.					
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PREFACE

This project was performed for the Office of University Affairs, National Aeronautics and Space Administration, by the Environmental Research Institute of Michigan (ERIM) in cooperation with Michigan State University (MSU). The Environmental Research Institute of Michigan, a non-profit corporation, was established on 1 January 1973 as successor to the Willow Run Laboratories of The University of Michigan. This report covers work performed from 1 June 1974 through 1 June 1975; it is one of a series presenting the results of the program.

The goal of this project is to demonstrate the successful use of earth resource survey technology in the solution of problems in land and water resource management of current concern to public agencies.

The investigations described herein were carried out under NASA Grant NGR 23-005-552. Joseph A. Vitale, Chief, Engineering Design Branch, Office of University Affairs, acted as Technical Monitor. The work was performed under the direction of Donald S. Lowe, Deputy Director of the Infrared and Optics Division at ERIM. The program was coordinated with a similar one conducted by Michigan State University under a separate grant.

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INTRODUCTION AND SUMMARY

During the past year, the Environmental Research Institute of Michigan brought to completion a number of successful applications of remote sensing technology. As a result, important decisions were made and implemented on the management of natural resources in many areas of Michigan, and the effective use of remote sensing led to the adoption by state and local agencies of operational procedures based on remote sensing data for future data collection and decision-making. Remote sensing data obtained during flight missions conducted by the NASA-supported ERIM C-47 aircraft along 3000 km of Michigan's Great Lakes shoreline in April and May 1974 and U-2 photography in the Upper Peninsula in July 1974 have made possible many of the applications undertaken. This data base will continue to be of great value for the future use of remote sensing.

This section summarizes the year's accomplishments, with specific results and actions underlined for emphasis. In following sections of the report, each of the applications is described in more detail.

1.1 CRITICAL SHORELANDS REGULATIONS

Michigan's Great Lakes shorelands constitute one of the State's most important natural resources, providing a great variety of economic, recreational, ecological, and aesthetic benefits. To maintain these benefits, the State must effectively manage its shorelands to protect them from erosion and flooding caused by high lake levels and storms, encroachment of residential and industrial development, and pollution of nearshore waters. The Michigan Department of Natural Resources (DNR) has been designated as the lead agency to provide this management. Operating under the Michigan Shorelands Protection and Management Act of 1970, DNR is legally required to delineate, evaluate, and

institute management plans for all high-risk erosion areas along 1100 km of shoreline, and environmental areas along 800 km of shoreline.

For all shorelands within their jurisdiction, local zoning boards are required to prepare ordinances which meet DNR requirements for management and set limits on development in high-risk erosion areas and environmental areas. To prevent damage to buildings for a 30-year period after construction, building location must be limited to an area beyond a designated setback distance from the bluff line. This setback distance can be established by knowing the average recession rate of the beach.

Working with the Water Development Services Division of DNR, ERIM has demonstrated the usefulness of remote sensing methods for measuring beach recession rates. Practical procedures for making recession rate measurements with sufficient accuracy for setting zoning regulations have been worked out by ERIM using historical and current photography. As a result of this work, DNR has now adopted remote sensing imagery as its primary tool for determining beach recession rates in order to establish setback limits within high-risk erosion areas. Proposed zoning ordinances based on these measurements have already been reviewed or approved in several counties, and other zoning actions are underway.

1.2 SHORELINE ATLAS

The use of the NASA shoreline flights of April and May of 1974 for implementing shoreland zoning decisions is only one of many possible uses of the data. To facilitate these additional uses, a shoreline atlas concept was developed under the grant. The atlas represents an important opportunity to develop aerial photography and photointerpretation techniques into a routinely used information resource for all coastal zone decision-making in the State. It

fulfills the need for documenting land use and development patterns along the shoreline, while providing a readily accessible information source for DNR staff and local agencies concerned with managing coastal areas.

A prototype of the atlas was prepared by ERIM and delivered to DNR. On the basis of this presentation, DNR adopted the concept and is funding ERIM to create the first example of this in the Michigan Thumb (a six-county region in the eastern part of the state). It is expected that this effort will be extended to the rest of the State later in 1975. ERIM will work directly with local units of government during assembly of the atlas and will therefore have the opportunity to encourage and participate in the use of the atlas for decision-making at local government levels.

1.3 NEW MEASURES FOR WETLANDS PROTECTION

In response to increasing public recognition of the recreational and ecological value of the State's extensive wetland areas, new legislation has been proposed in Michigan to establish a formal state program to identify, protect, and where possible, acquire these critical environmental areas. House Bill 4618 would require the Michigan Department of Natural Resources to conduct a special inventory of the state's wetlands resources and prepare a plan for their subsequent use, management, and protection. At the same time, it would prohibit dredging and construction in wetlands, and require a permit for any other uses or developments. The passage of this bill will require a whole new program area of environmental inventory and monitoring, and land-use planning and regulation within the State.

As one of the central objectives of the NASA Grant, ERIM has actively worked to promote the objectives of the bill, principally by demonstrating that remote sensing can provide the needed information for management. We have worked with governmental resource

management agencies, legislative groups, and citizens concerned about environmental quality. At the state level, our work has been done in cooperation with DNR, specifically, the Wildlife Division, Office of Land Use, and Parks Division. Our effort included the recommendation of features of the wetlands bill that will facilitate the use of effective remote sensing methods of data collection and analysis. We have also provided to citizen conservation organizations remote sensing imagery illustrating examples of wetland destruction.

Our strategy under this program has been to achieve both long-range goals, through environmental advocacy and policy formulation guidance, and short-range goals, through activities related to immediate government objectives. As a result of our activities, a number of significant accomplishments have been achieved during the past year. These accomplishments fall under the following headings.

***State Adopts Improved Wetland Classification System**

ERIM provided material assistance to the Michigan Land Use Classification and Referencing Committee in selecting an optimum system of wetland classification that would ensure the compatibility of remote sensing input with the operational use of the classification system. Our assistance to the Wildlife Division of DNR eventually resulted in the adoption by the Office of Land Use of the Golet/Larson system as a basis for wetland classification. The advantage of this system is that it categorizes wetlands mainly on the basis of the dominant life-forms of vegetation, a parameter easily and reliably identified by remote sensing methods and well adapted to provide appropriately detailed information for analysis and decision-making purposes.

*Introduction of Improved Methods of Resource Inventory

Another accomplishment is based on the development of new methods for evaluating wetland management strategies and measuring the current status of resource condition on a local basis. We have demonstrated to DNR methods of land use analysis using comparisons of historical and current photography to quantitatively assess changes in wetlands. This method has already been applied by DNR in helping to settle a dispute concerning the construction of the new 320-hectare State Secondary Complex southwest of Lansing.

To provide needed management data on the current condition of wetland resources, we have taken advantage of other work done at ERIM to show that processing and analysis of LANDSAT data provides an effective and economical method for large-area mapping and analysis of waterfowl habitat. This approach to large-area inventories is currently under consideration by the Wildlife Division as a better means of analyzing wildlife habitat and as a means of producing the statewide inventory that will be required by the wetlands bill.

*Advanced Remote Sensing Capabilities Illustrated

We have reviewed and presented to several DNR branches a wide range of demonstration wetland mapping products for a comparative evaluation of their utility. The alternatives illustrated for various wetland mapping purposes included high-altitude and low-altitude aerial photography, space photography, multispectral scanner and radar imagery. This presentation received a very favorable response and is being followed up by a technical report for widespread distribution to all levels of state and local government.

*Acquisition of St. John's Marshland Recreation Area

The State of Michigan is proposing a new and unique recreation area that will involve the acquisition of 1,260 hectares of wetlands along the northeast shoreline of Anchor Bay in Lake St. Clair to create Michigan's first ecological park. ERIM assisted DNR in meeting its obligation to provide technical justification for acquisition of the wetland complex. From remote sensing data, ERIM derived and provided detailed information needed as part of the environmental impact statement for the St. John's Marshland Recreation Area. Our technical findings will serve as a key ingredient for justifying the authorization of \$3 million in funding for the first phase of park acquisition of 1,240 hectares of undeveloped wetlands and farmlands.

*Statewide Remote Sensing Wetlands Inventory

If House Bill 4618 is passed, DNR will be allowed only 18 months to conduct a statewide survey of Michigan's wetland resources. Since conventional techniques for conducting this survey would require a large special appropriation of funds, DNR is interested in identifying alternative survey strategies taking advantage of the cost and time saving characteristics of remote sensing techniques to accomplish the survey within strict time and budget constraints. ERIM has recommended as the optimum survey strategy a multistage sample approach using LANDSAT data as the primary inventory tool, with adjustments to the estimate using low-altitude color infrared photography.

1.4 UPPER PENINSULA REGIONAL RESOURCE MANAGEMENT

Regional planning and development commissions are in the vital position of acting as resource centers for economic, social, and environmental planning and development. Recognizing the opportunity these agencies offer for the extension of remote sensing technology to the many potential users at the regional level, the project under-

took a program to provide technical assistance through the three agencies in Michigan's Upper Peninsula.

The basic data source available for these applications was provided by a U-2 photographic mission over the Upper Peninsula shoreline flown by NASA in July 1974. ERIM conducted a training workshop, a public seminar, and several meetings at various points in the Upper Peninsula to acquaint the regional staffs and other users with the data base and to instruct them in its use.

A wide variety of accomplishments have resulted from this effort. Specific examples include modification of a proposed shoreline recreation development to protect a waterfowl breeding area, environmental assessment of a proposed industrial park site, assistance to a federal grant proposal for an Indian community project, forest compartment planning, snowmobile trail selection, airport zoning, and meeting the shoreline mapping requirements of the Coastal Zone Management Program. A large audience of potential users was reached by this program and current indications are that the technology demonstrated by the program is continuing in active use.

1.5 SOIL SURVEY IN JACKSON COUNTY

Operational soil surveys conducted throughout Michigan provide a comprehensive and accurate source of data widely disseminated to many private and public users -- farmers, forest managers, urban planners, and civil engineers.

Past experience at ERIM in soils mapping has indicated that the use of multispectral scanner data can increase the speed, economy, and accuracy of the operational procedures for conducting these surveys. To demonstrate these capabilities, the project participated in the National Cooperative Soil Survey begun in Jackson County in the fall

of 1973. Multispectral scanner data and aerial photography collected over parts of Jackson County in April 1974 were used operationally to assist the survey personnel. An evaluation of the results indicates that the thermal bands of the multispectral data contain the most useful information for soil survey purposes. The operational survey work demonstrated the ability of temperature differences to delineate the distribution of organic and mineral soils. It is probably feasible to provide additional information on soil texture by ratio-processing of thermal imagery in two adjacent bands. Currently, the staff of the Soil Conservation Service and the Michigan Agricultural Experiment Station are continuing to work with the imagery to evaluate its role in future operational soil surveys.

1.6 OTHER ACTIVITIES

Among the other contacts made by the project staff during the year were the following:

- Washtenaw Land Conservancy, Inc.
- Michigan Public Service Commission
- City of Ypsilanti, Michigan
- Eastern Michigan University
- Wayne State University

Contacts with Eastern Michigan University are a continuation of a cooperative effort with members of its Geography Section. The project provided NASA RB-57 color-IR photography to Eugene Jaworski and C. Nicholas Raphael, members of the Geography Section, to enable them to analyze and measure coastal wetland areas along the shores of Lakes St. Clair and Erie. This work resulted in the documentation of long-term and short-term changes in coastal marshlands, including those resulting from both recent high lake levels and from residential

and industrial development. The documentation identifies the physical characteristics which contribute to either the protection or destruction of marshland areas, and recommends measures for preserving or restoring coastal wetlands in these southeast Michigan areas. These recommendations will be of direct use to the Michigan Department of Natural Resources, which has responsibility for establishing and carrying out coastal zone management policies for Michigan shorelands. The results of this work were presented by Jaworski and Raphael at a meeting of the Michigan Academy of Science, Arts, and Letters in Ann Arbor, Michigan [1] and will be published in the Michigan Academician.

CRITICAL SHORELANDS REGULATIONS

The Michigan Department of Natural Resources (DNR) has been designated as the lead agency for the purpose of managing the State's Great Lakes shorelands. DNR obtains its mandate from the Michigan Shorelands Protection and Management Act of 1970 (State of Michigan, Act 245), which also gives zoning and regulatory responsibility to the local governments within bounds set by DNR. Under the Michigan Shorelands Protection and Management Act, DNR is legally required to delineate, evaluate, and institute management plans (covering limits on development and use, necessary protective structures, and recommendations for state acquisition) for (1) all high-risk erosion areas along 1100 km of shoreline, including threatened structures in these areas; and (2) environmental areas along 800 km of shoreline. For all shorelands within their jurisdiction, local zoning boards are required to prepare ordinances which meet DNR requirements for management and set limits on development in high-risk erosion areas and environmental areas. If local boards fail to take the proper zoning action, responsibility passes to DNR to evaluate and approve all development plans within the designated areas.

In addition to its responsibilities under the 1970 Michigan Act, DNR has been assigned to oversee Michigan's compliance with the U.S. Coastal Zone Management Act of 1972 (U.S. Public Law 92-583). Under this act (administered by NOAA) management plans must be prepared and instituted for the entire coastal zone, consonant with national, regional, state, and local goals.

During the year, ERIM continued its program of assisting DNR in fulfilling these statutory requirements for managing the Great Lakes coastal zone. ERIM worked in cooperation with the Water Development Services Division of DNR's Bureau of Water Management.

ERIM also cooperated with local governments through their planning and zoning boards.

Over 1100 km of Michigan's shoreline have been determined to be in a high-risk erosion condition. Upon request, DNR must provide recession rate data to 226 local units of government who must establish setback lines by spot zoning in high-risk erosion areas. DNR is also required to provide shore erosion rates to approximately 500 owners of some 350 km of eroding, unplatted, and undeveloped property. In addition, DNR is frequently requested to provide to local agencies and the public, recession rate information for already developed areas. The objective of this management effort is to minimize the adverse effects of erosion, flooding, and unrestricted development in shoreland areas, resulting in property damage and loss of critical environmental areas.

The usefulness of remote sensing methods for performing these functions was established as early as 1972. At that time, ERIM undertook a pilot project funded by the Water Development Services Division to demonstrate suitable remote sensing methods for measuring beach recession rates, a fundamental step in the process of establishing suitable zoning restrictions.

The remote sensing data needed for recession rate measurements was obtained by the ERIM NASA-supported C-47 aircraft during April and May 1974. The data included color and color-infrared photography and MSS data for at least 3000 km of Michigan's 3700 km of mainland shoreline. The color aerial photography, at scales of 1:10,000 and 1:16,000, provides data with excellent resolution. The SO-397 color film greatly increases the interpretability for land and water features as compared to black-and-white photography.

During the current year, ERIM completed the task of selecting and applying suitable remote sensing methods for measuring beach

recession rates and transferring its experience in the use of these methods to DNR personnel.

The procedure for making recession rate measurements worked out under the pilot project was further developed to meet accuracy requirements for these measurements. The remote sensing measurement technique uses standard aerial photography obtained on two different dates to measure changes in the beach shoreline during the interval. In order to maintain the high accuracy required, special procedures had to be worked out for making necessary photogrammetric corrections for parallax displacement, tilt, etc. A quantitative evaluation of the accuracies which could be achieved by using these procedures was also made and delivered to DNR in accordance with their request.

As a result of this work, DNR has now adopted remote sensing imagery as their primary tool for evaluating shoreland areas for certain management purposes [2,3]. The Water Development Services Division has been using the 1974 photography to delineate high-risk erosion areas and determine beach recession rates within these areas. Black-and-white matte prints covering over 3000 km of shoreline have been provided to DNR, in accordance with their request, for use in the measurement program.

The aim is to prevent damage to buildings, including septic systems and tile fields, for a 30-year period after their construction by requiring a setback distance from the bluff. Presently developed or platted property is not affected because the previous legal status of these properties cannot be altered under Act 245. Only undeveloped, unplatted property in areas designated as having significant erosion are affected. However, a local zoning ordinance may affect all high risk property. Required building setback is determined by assuming that the recession rate will continue for a period of 30 years at the value of the average annual recession rate determined from measurement of the aerial photography.

The measured rates are thus the criteria upon which the local zoning boards establish setback limits to be imposed for construction in high erosion areas. Proposed ordinances for the following jurisdictions are being reviewed or have been approved:

Chikaming Township, Berrien Co.

Delaware Township, Sanilac Co.

Burt Township, Alger Co.

Keweenaw Co.

Other zoning actions, currently underway, or initiated in the future, will make continuing use of the remote sensing procedures described above.



FIGURE 1. MARSHLAND IN GRATIOT-SAGINAW STATE GAME AREA. Michigan's wetlands constitute one of its most valuable resources. A State program to protect these wetlands will rely on remote sensing surveys for much of the information needed to plan the preservation and management of these areas.

NEW MEASURES FOR WETLANDS PROTECTION

3.1 THE NEED FOR STATE LEGISLATION

Past efforts to preserve wetlands at the state and local level in Michigan have been characterized chiefly by a piecemeal approach to the problem. For example, public acquisition of endangered wetlands of obvious value typically has been accomplished as a component of broader programs for fish and wildlife management, park acquisition, or open space preservation. A bill introduced in the last session of the Michigan legislature promises to improve this situation, however. The central theme of the proposed legislation is a new concept in the areas of environmental conservation and land-use planning and regulation, which embodies the realization that wetlands possess intrinsic public and ecologic values sufficient to warrant the establishment of a formal state program to identify, protect, and where possible, acquire these important ecosystems.

House Bill 4618, known as the wetlands bill, would create a new public act which will require the Michigan Department of Natural Resources (DNR) to conduct a special inventory of the state's wetlands resources and prepare a plan for their subsequent use, management, and protection. At the same time, it will prohibit dredging and construction in wetlands, and require a permit for any other uses or developments. Persons violating the act will be guilty of a misdemeanor and assessed a fine ranging from \$200 to \$1000. The passage of this bill will mean the creation of a whole new program of environmental inventory and monitoring, and land-use planning and regulation within the State.

3.2 ROLE OF REMOTE SENSING

ERIM's past participation in remote sensing projects involving wetlands and familiarity with the benefits that remote sensing has to offer in wetlands work has convinced us that remote sensing can and should play a major role in this new wetlands preservation program. Whether remote sensing will play such a role is another matter. If left to chance, the influence of past practices, lack of awareness, and inertia could allow the development of policies which permit few opportunities for the use of remote sensing or result in an uphill battle to promote its acceptance at a later date. Rather than let this happen, one objective of the Grant's activity over the past year in this subject area has been to mount an especially vigorous campaign on many fronts to promote the orientation of this emerging state program in such a fashion that remote sensing becomes an integral part of it. We feel that this will ensure that present and future remote sensing capabilities will have a real influence in Michigan in the future development and practice of this new and important aspect of land use regulation.

During the past year we have identified a number of the specific issues whose resolution in a particular fashion will greatly enhance the role remote sensing will play in the proposed wetlands program. It is useful to mention a few of the more important issues here as an appropriate introduction to the scope of our involvement in this Grant program area. To begin, there has been the problem of developing an adequate definition of wetlands and subsequently, wetland classification criteria. The selection of a standard wetland classification system for current use that is also compatible with historical data analysis has been another important problem. Last, but certainly not least, is the need to carefully consider the feasibility of using a remote sensing technique for making a meaningful total-

enumeration survey of the entire state within the 18-month period required by the bill.

In guiding the identification, evaluation, and selection of alternatives for these and similar issues, ERIM has acted in the role of catalyst, liaison, technique performance evaluator, consultant, environmental advocate, and team member of an ad hoc operational DNR working group. In these different capacities, we have worked with or been involved with agencies or groups that can be roughly divided into three categories: governmental resource management agencies, legislative groups, and citizens concerned about the quality of our environment. Within DNR, we have concentrated our efforts in the Wildlife Division and Office of Land Use, the branches which will probably have operational responsibility for implementation of the proposed wetlands program. We have also worked with the Parks Division, although here the emphasis was a more general thrust at showing the staff how remote sensing data and imagery could substantially improve environmental impact statements. Representative examples of other organizations, outside DNR, with whom we worked include the National Wetland Classification Workshop (U.S. Fish and Wildlife Service), the Michigan House of Representatives Committee on Conservation, Environment, and Recreation, the Michigan Environmental Network and the Natural Areas Council, and the Detroit News and Ypsilanti Press.

The remainder of this section briefly describes and illustrates our strategy for achieving our objectives, discusses some of the Grant's signal accomplishments during this past year, and illustrates the means and materials that have been used to make our points.

3.3 STRATEGY OF GRANT ACTIVITY

The specific tasks which formed the past year's Grant program on this subject can be divided into three general types of activity. The

first could loosely be described as environmental advocacy. It focused on refining the content and building up support for the wetlands bill, so that the policy formulation that will eventually be derived from the bill will be amenable to maximum remote sensing input. A major task under this general grouping of activity consisted of working with concerned citizen groups to develop a definition of wetlands that met two major requirements. First, the definition and supporting wetlands classification system should be designed to permit the remote identification of wetlands, so that efficient and economical methods of remote sensing could be used for mapping and evaluation purposes. Secondly, the definition must meet the requirement of being adequate ecologically without being overly inclusive, a situation that would be likely to arouse political opposition from agricultural and timber interests, because the definition would restrict their operations on too much of the State's land.

Another occupation under this activity heading was that of providing remote sensing imagery illustrating examples of wetland destruction to citizen conservation organizations, who have used them to dramatize the problem and build up local support. At the same time, we have also furnished information to major newspapers in the southeastern Michigan area illustrating how the State is planning to use advanced remote sensing techniques to solve these problems, as evidence of governmental concern and NASA's role in successfully applying to a local problem advanced technology, whose development was paid for by public taxes. (See Appendix A).

The second type of activity the Grant fostered was that which has influenced the manner in which wetlands are viewed as a component of the landscape in DNR management and planning activities. The State of Michigan has recently begun a move toward comprehensive land use planning. As part of these efforts, a state land use classification

system has been prepared for use in mapping and monitoring both the State's physical resources and the activity on its land surface. The manner in which this system treats wetlands, in relation to other types of physical landforms and cover and actual land use, constitute a policy decision regarding what information about wetlands is significant. This decision will have a great bearing on the role remote sensing will be able to play in fulfilling future wetland information needs. The activity we engaged in under this heading we describe as policy formulation guidance and centers principally upon our efforts at assisting the Michigan Land Use Classification and Referencing Committee in selecting an optimum system of wetland classification. Through our participation on the committee we were able to make certain that a classification system was adopted that relied upon criteria which were remotely detectable, thereby ensuring the compatibility of remote sensing input with the operational use of this classification system. This results in a built-in bias toward reaping the advantages of remote sensing whenever future planning or management work is considered in the State.

In both types of activity discussed above, the results of the Grant's efforts will tend to be realized as long-term payoffs, and, of course, are immensely important to the long-range acceptance of remote sensing at the state level. At the same time we were pursuing these goals, however, we have not neglected directing our effort toward short-range goals, as well. These, we are happy to report, have had an immediate payoff in improving current DNR operational methodologies relating to wetlands mapping and analysis. In accomplishing this latter task two sub-groups of DNR projects were addressed: routine projects and special projects.

Routine projects, such as local wetland mapping and analysis and environmental impact statement preparation, are those undertaken to develop better management or acquisition plans. As a practical

illustration of how the techniques and approaches that ERIM has recommended for use by DNR can be applied to more easily or effectively accomplish these purposes, we have used them in a demonstration project in which the resulting information forms the scientific data base of an environmental impact statement for the St. John's Marshland Recreation Area. DNR will use our findings as justification to obtain a \$1.5 million appropriation from the Bureau of Outdoor Recreation. This will then be matched with equal state monies and used to buy this 1260 hectare wetland complex in the Detroit Metropolitan area, which will become Michigan's first ecological park.

Under the subheading of special projects, our major interest has been the development of a conceptual approach and survey methodology for a statewide, total-enumeration inventory of Michigan's wetland resources, which can be completed in 18 months or less.

We believe that the combination of all the results of the activity described above, which form the three major concentration areas of the past year's Grant program, will prove to be the most effective means of accomplishing two objectives furthering the acceptance of remote sensing in our State's emerging program of wetland protection and demonstrating its use for decision-making and resulting actions. The highlights of the year's program, comprising the stories behind the accomplishments of specific tasks, are covered next.

3.4 MILESTONE ACHIEVEMENTS

3.4.1 STATE ADOPTION OF IMPROVED WETLAND CLASSIFICATION SYSTEM

The purpose of the Michigan Land Use Classification and Referencing Committee was to develop a standardized land use classification system for the State. In February, 1974 the committee issued its first draft of a statewide classification system. This system consisted of a four-level hierarchical land use classification scheme which could be further expanded by local governmental units

to fit their particular needs. Levels I and II of this system correspond to the federal system proposed by Anderson, Hardy and Roach in USGS Circular 671 [4]; Levels III and IV were developed by the committee.

The wetlands portion of the system as originally proposed was essentially those same classes of wetlands described and used in Fish and Wildlife Service Circular 39 [5]. ERIM staff members have experience working with this system and have found several problems associated with it. Chiefly, these are that the wetland classes in this system are so broadly generalized that each time the system is applied, each mapper must establish his own set of detailed mapping criteria and conventions. Furthermore, enough latitude exists in the formal specification of the Circular 39 types so that it is also likely that different users will apply it in different ways in different regions.

These and other concerns were made known to Wildlife Division staff through joint ERIM-DNR meetings initiated under the Grant program. At these meetings we explored these shortcomings in detail comparing potential results obtainable with the new state classification with the results obtained from work sponsored by NASA in the past (such as our work at Pointe Mouillee [6]), which illustrated the difficulties in using this new system. The result of these seminars was that DNR asked us for our opinions and recommendations for a better system that they might use.

The system recommended by ERIM is a new one recently developed for use in the northeastern U.S. by Golet and Larson [7]. The main benefit of adopting this system is that it categorizes wetlands mainly on the basis of the dominant life-forms of vegetation. This, of course, is a parameter easily and reliably identified from the aerial perspective, so that the underlying basis of the Golet/Larson

system is inherently compatible with remote sensing. In addition, the fact that it permits categorizing wetlands on the basis of what is actually present locally makes the use of automated processing of remote sensing data feasible. The holistic approach to wetlands classification required by Circular 39, requiring the appraisal of relatively large physiographic areas as a unit, would prove difficult to use with data classification procedures which work on a cell-by-cell basis.

A revised state land use classification system was issued by the Office of Land Use in November, 1974 in which the wetlands portion was changed from the Circular 39 system to that of the Golet/Larson system. We feel that the acceptance of the Golet/Larson system is a significant step towards ensuring that advanced remote sensing technology will be able to play a significant role in wetland research, management, and protection in Michigan.

3.4.2 INTRODUCTION TO IMPROVED METHODS OF RESOURCE INVENTORY

Effective resource management requires two kinds of information: (1) how well present management strategies are accomplishing projected goals, and (2) the current status of resource condition on a local basis. At ERIM we have developed new methods for answering these types of questions for wetland areas. Through the Grant's support we have been able to bring these methods to the attention of DNR planning and field staff who have realized their worth and are already applying or seeking to apply them to improve their everyday working efficiency.

To answer the first question, "How well are present management strategies working?", we have demonstrated the use of land use analysis using comparisons of historical and current photography to quantitatively assess changes in the environment. These changes are then correlated with known management practices and the result is a

gauge of the treatment's performance. The effectiveness of this approach, of course, depends on using a scene classification system that can be used adequately with historical photography, that is to say, with no ground truth. Since the State's new wetland classification scheme relies primarily on physical characteristics that are observable from the aerial perspective, this technique will fit in well with future routine mapping work and forms a logical extension of it. Furthermore, the cellular method used in tabulating scene data lends itself especially well to the use of computers which removes the tedium of the method and makes feasible the examination of relatively large areas.

DNR is already beginning to explore the potential of the technique, and its use in a rudimentary form has been used to settle a dispute between the State Department of Management and Budget and the Michigan United Conservation Clubs over the future of a wetland threatened by construction of the new 320 hectare State Secondary Complex southwest of Lansing. On the basis of analysis of current and historical photography, the true history of the marsh in question was ascertained and a reasonable plan for its preservation developed [8].

In addressing the second question, "What is the current condition of resources, locally?", a different approach is needed. Here time and accuracy are of the essence. In determining how best to spend a limited budget, the manager must know where the greatest need for resource improvement or condition will coincide with the greatest demand. This requires that an almost simultaneous picture of local resource condition be available. Since the costs of large-scale field inventories traditionally used to obtain this are prohibitively expensive, a better method is needed.

For wetlands we at ERIM think the method is special-purpose analysis of recognition-processed LANDSAT data. Under LANDSAT-1 contracts, ERIM developed strategies to map important classes of

wetlands in Michigan to an accuracy of 90 percent [9]. Under the same contract, we subsequently developed software that can be used to analyze the spatial arrangement of the landscape, as portrayed by the recognition processed data, to rate local units of landscape in terms of waterfowl habitat quality.

Using these results, we have shown the Wildlife Division of the DNR how processing and analysis of LANDSAT data provides an effective economical method for large-area mapping and analysis of waterfowl habitat. We have pointed out the special attributes of LANDSAT that make it a valuable ally for the resource manager facing the problem of analyzing resource condition over large areas. These special attributes include (1) large area coverage with adequate resolution, (2) the ability to keep resource inventories up to date through frequently repeated coverage, and (3) providing a cost-effective means of resource analysis, because the spatial and spectral data are already encoded on magnetic tape suitable for computer analysis.

This approach to large-area inventories is currently under consideration for use by the Wildlife Division in several ways. Among the most interesting of these potential uses is the possibility of using it in an animal/environment interaction context to aid in developing better models of what constitutes quality wildlife habitat.

This also is one of the major remote sensing systems the State is considering for use in accomplishing the statewide inventory they will be required to perform if the wetland bill passes.

3.4.3. ADVANCED REMOTE SENSING CAPABILITIES ILLUSTRATED

The objective of this task was to pull together a wide range of demonstration wetland mapping products, generated by different remote sensing systems, for use as a technical basis for a comparative evaluation of their performance. This summary presentation of products is providing a set of mapping system alternatives

from which persons in different levels of government in the State can select the remote sensing system to most expeditiously accomplish their wetland mapping tasks.

Nearly the full range of operational advanced remote sensors has been reviewed. In addition, the effects on their performance when used in different platforms has also been examined. The systems specifically included are:

- A. Photography
 - (1) High vs Low Altitude
 - (2) Multispectral
 - (3) From Space
- B. Multispectral Scanners
 - (1) Aircraft
 - (2) LANDSAT
- C. Radar

For aerial photographic systems, recommendations have been developed for film/filter combinations, scales, and time of year to fly, in order to get the best look at different types of wetlands. The special advantages of aircraft MSS systems for automatically delineating certain features such as upper wetland boundaries associated with a land/water interface have also been stressed. Shoreline flooding and vegetation mapping at Pointe Mouillee performed under the Grant in 1972-74 using ERIM's scanner served as a good illustration of this capability [6].

LANDSAT capabilities for large area wetlands mapping have been illustrated by presenting and discussing results of automatic processing of satellite data over southeastern Michigan sponsored by NASA as a LANDSAT-1 investigation [9]. The synoptic mapping capability of LANDSAT for application to statewide inventory work as mentioned earlier has been pointed out. In contrast to the

other systems that have been spotlighted, we have chosen to show radar work with wetlands as an experimental application. One capability in particular we have illustrated, however, is radar's ability to detect water under a foliage canopy. This capability promises to have considerable usefulness in mapping the extensive conifer swamps of the northern part of the State.

On 17 July 1975 a presentation summarizing this information was made to representatives of the following DNR branches: Wildlife Division, Office of Land Use, Hydrological Survey, and Fisheries. This presentation received an enthusiastic response, along with an expression of interest in learning more about the techniques discussed than could be covered in a single meeting. As a result, we are in the process of preparing a technical report to summarize all these findings for widespread distribution to all levels of state and local government. By including information on how and where to obtain these remote sensing services on an operational basis, as well as estimated costs, we expect to go a long way towards overcoming the inertia barrier that now prevents persons from using many of these techniques. This report alone should significantly increase the use of remote sensing in wetlands work in the State.

3.4.4 ACQUISITION OF ST. JOHN'S MARSHLAND RECREATION AREA

The State of Michigan is proposing a new and unique recreation area in the Detroit Metropolitan area that will involve the acquisition of 1260 hectares of wetlands along the northeast shoreline of Anchor Bay, Lake St. Clair (see Figure 2). The Michigan Natural Resources Commission (a policy board consisting of a five member commission of prominent citizens appointed by the governor) formally established the project in September 1974. Significantly, a photo-mosaic of the proposed acquisition site, made from NASA shoreline color photography paid for by the Grant, was supplied to the



FIGURE 2. HIGH ALTITUDE PHOTOGRAPH OF LAKE ST. CLAIR SHOWING ST. JOHN'S MARSH. St. John's Marsh, at the right edge of the photo, is the projected site for Michigan's first ecological park.

DNR wetlands management and Parks Division staff for use in briefing the Commission on the proposed project at the commission's monthly meetings which led up to formal approval of the project.

This project is a first for Michigan. It will not only save a marsh and wetlands area from destruction (See Figure 3), but at the same time, will provide a place where the public can gain a better understanding and appreciation of wetland ecosystems and their relationships in the "web of life". When fully developed, the area will be operated on a day-use basis with the wetlands environment and its place in the scheme of nature as the central theme. Interpretive programs will be developed around the marsh ecosystem for the general public as well as for school systems in southeastern Michigan. The emphasis will be to make this area an "ecological park", not a typical high-density, "picnic, swimming, and games" facility.

Because the projected use of Michigan's regular annual apportionment of federal Land and Water Conservation Funds for both local and DNR projects will exceed monies available in each fiscal year in the foreseeable future, a special appropriation from the Bureau of Outdoor Recreation (BOR) is being requested. This special appropriation will serve to accomplish the first of the project's two acquisition phases. Phase One will concentrate on the immediate purchase of the undeveloped wetlands and related open farmlands along the north and east project boundary lines. Phase Two is a long-range proposal that will allow DNR to purchase the remaining developed areas as parcels become available.

The cost of the Phase One acquisition, which involves 1,240 hectares of land, is anticipated to be approximately \$3 million. Of this total, the State of Michigan will request \$750,000 from the Secretary of Interior's Contingency Reserve Fund and \$750,000 will be utilized from the State's regular BOR apportionment. The remaining

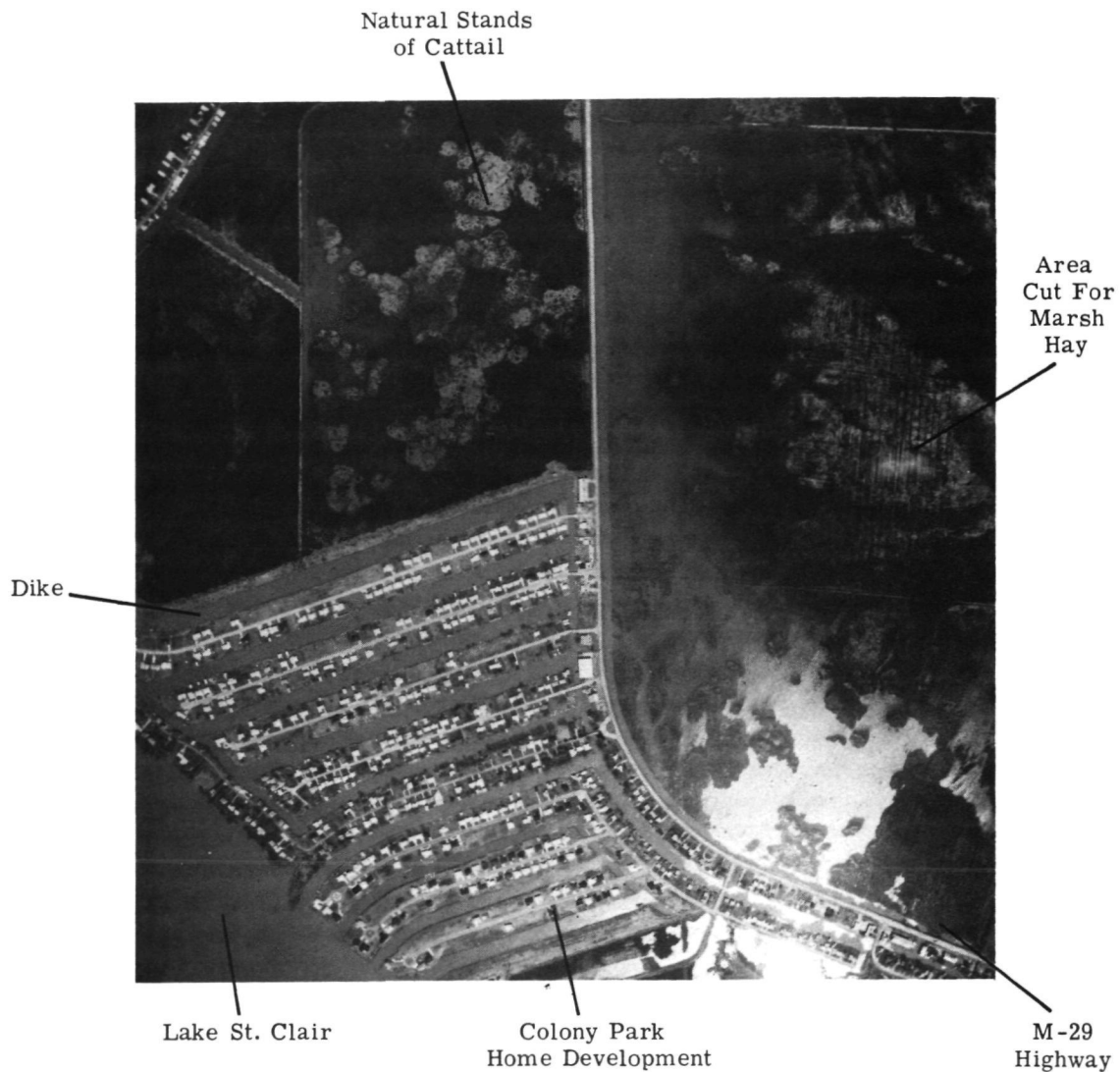


FIGURE 3. RESIDENTIAL DEVELOPMENT IN ST. JOHN'S MARSH. This photograph, taken during the ERIM flight mission along the Great Lakes shoreline of Michigan in the spring of 1974, shows recent residential development which threatens a wetlands area of major ecological value.

funds will be 50 percent matching money provided by the State. Four prominent state representatives, in a bipartisan effort, are currently involved in developing legislature support for a budget item in the 1976 DNR capital outlay request. These individuals are Warren Goemaere (D-Roseville), Joseph M. Snyder (D-St. Clair Shores), William L. Jowett (R-Port Huron) and Bill S. Huffman (D-Madison Heights). Goemaere, who is also sponsor of the proposed wetlands bill, is a former chairman of the House Committee on Conservation, Environment and Recreation, while Snyder, Jowett and Huffman are ranking members of the House Appropriations Committee.

An essential part of DNR's Phase One program is the preparation of an environmental impact assessment (E.I.A.) to comply with the NEPA requirements for obtaining the necessary federal funds. The posture taken in preparing this assessment is that without the protection afforded through acquisition and management, these wetlands will be lost through development and pollution. This would be an ecological disaster of the first order. St. John's Marsh is the last great block of remaining wetlands under single ownership along Michigan's shoreline. DNR describes the area as the "Michigan Everglades," an analogy which is quite deserved and accurate. St. John's Marsh lies along a major waterfowl migration corridor, supports a large population of game fish, and also serves as a significant fish spawning ground.

To make its point, DNR needed information that (1) illustrated the unique ecological nature of the marsh, and (2) quantitatively identified the pressures which are slowly degrading the quality of the area. The agents responsible for these pressures include both the encroachment of cultural activities including subdivision and marina construction, and damaging natural forces such as wind and wave erosion.

Here was a situation in which we felt ERIM/NASA, in the service of a good cause, could demonstrate the techniques we have been recommending the DNR adopt. To help the DNR make its case, we have tackled the job of furnishing the scientific information documenting the marsh's character and its probable fate, which is necessary for the E.I.A. We provided the DNR with three types of data: (1) visual products which include various types of imagery to put the marsh and its cultural and physical surroundings in perspective; (2) quantitative data derived from aerial photography describing the historical and current nature of the marsh in terms of the State's new land use classification system and the nature of the changes occurring between observations; and (3) cover type maps which graphically summarize the information contained in the statistics, but which also show the spatial significance of the data. We also plan to aid in the interpretation of the quantitative data and the process of integrating the information derived from remote sensing with the other recreational and social data DNR is using to prepare the formal E.I.A.

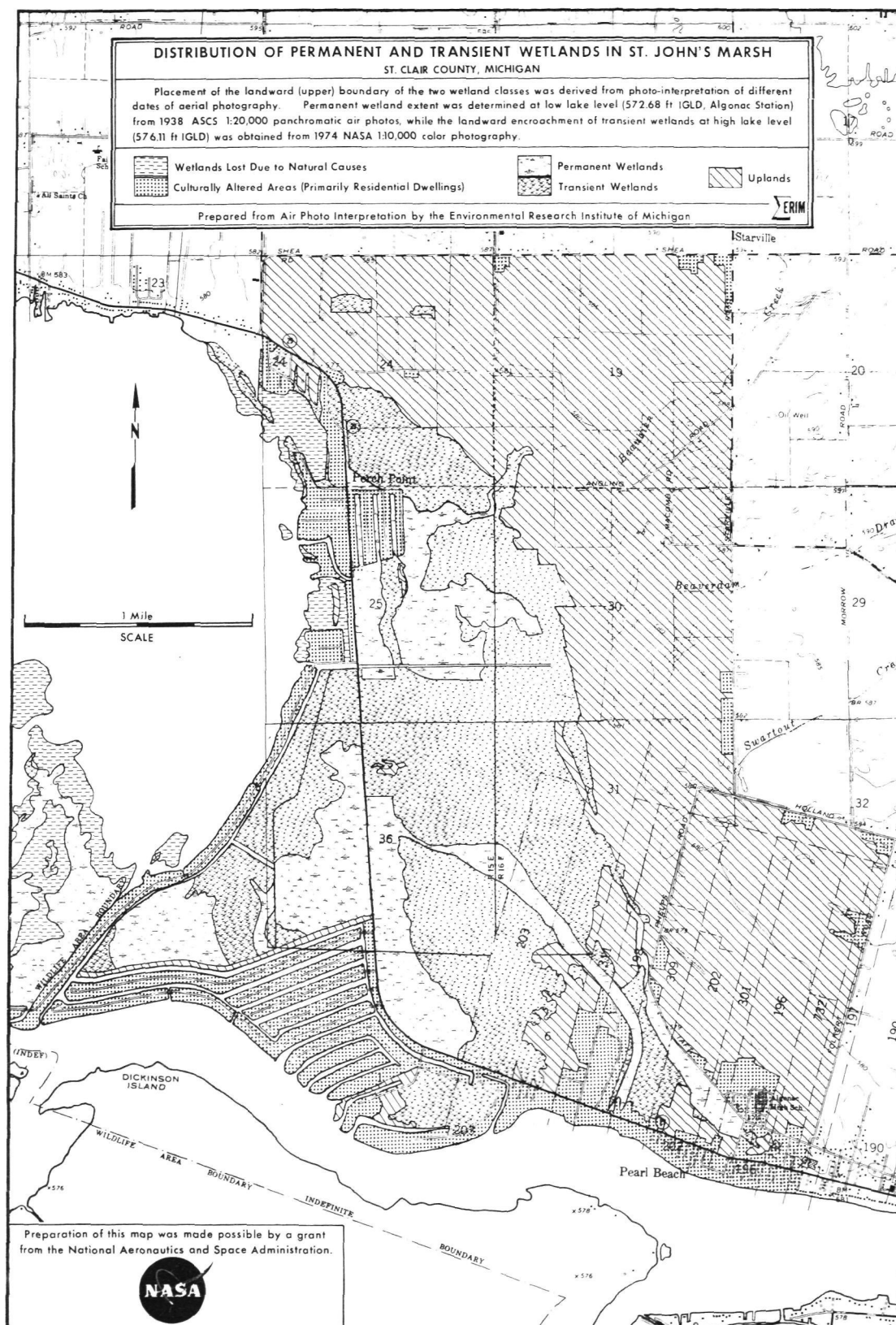
The basis of our technical work in the preparation of these data was joint photo-interpretation and land use classification mapping of 1937, black and white, 1:20,000 ASCS photography and 1974, color, 1:10,000 NASA shoreline aerial photography. Photo-mosaics of each set of data were prepared which provide a striking means of portraying the deleterious impact which the building of residential dwellings has had on the size of the marsh.

Using a cell-by-cell tabulation method, with a cell size of 1 acre, statistics were generated which documented the amount of the project area in each land use or cover type category present. Comparison of the category codes of a single cell for the two dates made it possible to identify the causes behind changes in the wetlands over the years. Figure 4 shows the changes occurring between 1937 and 1974. This and the maps for the two years (1937 and 1974) suitable for inclusion

in the E.I.A. were prepared from the photo-interpretation manuscript maps to provide a usual adjunct to the statistics described above. SKYLAB S190A space photography and RB-57 high-altitude photography (Figure 2) were used to portray the regional and cultural setting in which the project is set.

Internal DNR review of the complete BOR proposal is set for December, 1975. This will be followed by hearings before the Michigan Environmental Review Board in January, 1976, followed by public hearings through February. In March the proposal will be submitted to BOR, and upon approval Fiscal Year 77 funds will be forthcoming to go ahead with the project. A preliminary proposal has already been submitted to BOR to get their reaction to the merits of this project. From their favorable review of a preliminary proposal there is every indication that, assuming a good E.I.A. is submitted showing sufficient ecological and social justification, the project will be approved. NASA photography was featured in this preliminary proposal.

The final decision on approval of the park development project will be made on the basis of a number of factors, including political and economic considerations. However, the data supplied by remote sensing will be a major ingredient in the decision in that it supplies the ecological justification for the land acquisition. A key finding of the remote sensing analysis is evident from Figure 4. This figure shows that a large area of transient wetlands exists along the shoreline. The transient nature of these wetlands results from the cyclic varying of lake levels over the years. As a result, this area has high ecological value as a wetlands area and at the same time, is exceedingly unsatisfactory for the past and projected residential development. By emphasizing this key fact in the environmental impact statement and public hearings, a sound case can be made for the preservation of this unique wetlands complex.



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3.4.5 STATEWIDE REMOTE SENSING WETLANDS INVENTORY

If the state wetlands bill (HB 4618) is passed, DNR will have only 18 months to conduct a statewide survey of Michigan's wetland resources. DNR staff members have stated that if conventional techniques are used special appropriation funding on a very large order must be provided, which is very unlikely. Consequently, they are interested in working closely with us to identify several alternative survey strategies in which the cost and time saving advantages of remote sensing techniques could help them to fulfill this potential mandate.

Under this task we have developed several scenarios for the use of different remote sensing systems either singly or in combination. Two of the most promising sensor systems are color infrared airphotos and recognition-processed LANDSAT data. Our recommendation for the optimum survey strategy involves a multistage sample approach to a state survey using LANDSAT data as the primary inventory tool, with adjustments to the estimate using low altitude color infrared photography. The DNR feels this system could result in a two-thirds reduction of inventory costs over the use of strictly field methods with the potential result of a better set of baseline environmental data.

When our joint concept becomes solidified as to how this survey should be conducted, we intend to brief the legislative sponsors of the wetlands bill on the manner in which the nature of finally passed legislation will affect the performance and cost and time requirements of these candidate survey systems. In this way we hope to ensure adequate funding to support the remote sensing method we feel will best do the job.

3.5 OUTLOOK FOR FUTURE ACTIVITY

Our continuing work in this subject area in the coming year will focus on bringing to fruition the results of this past year's efforts, which will result in the passage of the pending wetlands bill, the first statewide wetlands survey in Michigan, in which remote sensing will play the lead role, and a growing use of advanced remote sensing techniques in the day-to-day management and protection of wetlands.

Issues already specifically identified as tasks for next year's program include the following:

- (1) Recommending to Representative Goemaere that an ad hoc "Michigan Wetlands Inventory Committee" be established consisting of persons from the DNR (biology and implementation), ERIM (remote sensing experts), faculty from the state universities (planning), and representatives from concerned citizen conservation groups.
- (2) Providing continued support to citizens' groups and legislators through helping to refine the State Wetlands Bill, thereby aiding in achieving its early enactment.
- (3) Giving any further assistance in preparing the Environmental Impact Assessment for St. John's Marsh to ensure that the State makes the best possible case for receiving BOR funds to purchase the area.
- (4) Publishing a technical report for widespread distribution in-state that compares the capabilities and costs associated with the variety of conventional and advanced remote sensing systems developed for wetland surveys. It will also stress the practical steps necessary in obtaining and analyzing the data produced by each system.
- (5) Presenting a workshop on "Practical Remote Sensing of Wetlands" at the DNR Wildlife Division In-Service Training Session in January 1976.

UPPER PENINSULA REGIONAL RESOURCE MANAGEMENT

Regional planning and development commissions do not in most cases act as decision making or law enforcement agencies. Rather, they collect information and make recommendations to legislative and executive bodies. Nevertheless, they are in the vital position of acting as resource centers for economic, social, and environmental planning and development. Their pivotal role makes them ideal agencies for initiating and coordinating remote sensing programs for their respective jurisdictions. Making available to them up-to-date remote sensing data and training them in its use are needed to make the commissions self-sufficient as remote sensing resource centers. They can then make effective use of available imagery in meeting their mandated responsibilities and in acting as more informed consultants to both the public and private sector where many planning and development issues are finally resolved.

4.1 GRANT ACTIVITY

In order to extend the adoption of remote sensing technology by users at the regional level, the project undertook a program to provide technical assistance for the three regional and planning and development commissions in Michigan's Upper Peninsula:

- Western Upper Peninsula Planning and Development Region (WUPPDR)
- Central Upper Peninsula Planning and Development Region (CUPPAD)
- Eastern Upper Peninsula Regional Planning and Development Commission (EUPRPDC)

Operations under the program beginning in the spring of 1974 were carried out primarily by Buzz Sellman of ERIM. Having developed the interest of the Upper Peninsula planning and development commission leaders in the opportunity to obtain and use remote sensing data of

their area, he worked with them in the spring of 1974 to design a U-2 high-altitude photographic mission over the Upper Peninsula shoreline that was approved by NASA. This mission was flown on 20 July and by the fall of 1974, the photography was delivered to the regional participants. At that time, an in-house training workshop was conducted in Escanaba for all three regional staffs. On 11 December 1974, a public seminar was held in Marquette at which presentations were made by both ERIM and MSU. From January to June 1975, several meetings were held at ERIM with regional staff and liaison with the regions was maintained. ERIM has continued to extend technical advice and respond to information requests.

4.2 RESULTS

In the past year, each of the regional planning groups has realized its goal of operating and sustaining an independent remote sensing program. Many of the applications discussed below are now complete, but a continuing range of services utilizing remote sensing is now provided through the three regional groups (see Appendix A).

The initial environmental mapping programs of all three regions is nearly complete, and the availability and use of the NASA U-2 photography has allowed the Upper Peninsula regions to achieve project goals under their respective Coastal Zone Management Programs far in advance of Michigan's eleven other regions. More specifically, the WUPPDR has completed a seven-category forest cover type inventory, mapped wetlands and shoretypes, and general land use to its entire shoreline from the U-2 photographs. CUPPAD staff have also inventoried and mapped shoreline types, general land use and wetlands and other sensitive environments along its shoreline. The EUPRPDC purchased NASA's low-altitude photography collected by ERIM in 1974 for its region and is using it to map all permanent structures along its shoreline.

WUPPDR staff used their mapped information to recommend changes to a proposed shoreline recreation development during their routine A-95 review process. Their proposed change, which was designed to protect a waterfowl breeding area, was accepted as a permanent modification to the project. Likewise, CUPPAD staff were asked to prepare an environmental assessment of a proposed industrial park site for the City of Manistique. The U-2 photography was the primary information source for this analysis.

The U-2 photography has also been very valuable for local planning and development issues. This past winter, planners at CUPPAD completed a land/water resources study for Menominee Township in preparation for a long-range development plan. The U-2 photography and resultant mapped materials are currently being used in public meetings for this project.

The Hannahville Indian Community sought the assistance of CUPPAD staff to prepare a federal grant proposal to start a hog farming operation. The photography proved a valuable data source for part of the field analysis required.

EUPRPDC staff are using the U-2 photography to help prepare a master plan for the Kinross Township fairgrounds and a timber inventory in Whitefish and Clark Townships.

WUPPDR staff are consulting with officials from several private firms in order to make the U-2 photography useful to their operations as well. The White Pine Mining Company, Homestake Mining, and Universal Oil Products have all ordered portions of the photography from the EROS data center and WUPPDR staff will continue as technical consultants for interpretation and analysis purposes.

Staff from Ottawa National Forest are using the photography for forest compartment planning.

Other applications include monitoring of environmental areas, snowmobile trail selection, airport zoning, and sea lamprey control.

Finally, both the Forestry and Geology Departments of Michigan Technological University are using the U-2 photography as course materials and in support of field research projects.

Both the scope and diversity of these programs speaks well for the goal of achieving a significant level of utilization of information supplied by NASA remote sensing programs. It is also clear that in this instance a very large audience of potential users has been reached and that identifiable products and results are being achieved.

This level of contact and involvement within the State can be achieved only by collaborating with existing local and/or regional groups who are in continuous contact with their constituents and thus able to immediately respond to issues and events. This program has been very successful and might serve as a useful model for future attempts to achieve broader and more effective utilization of contemporary remote sensing technology.

SOIL SURVEY IN JACKSON COUNTY

Operational soil surveys are conducted with emphasis placed on the speed, economy, and accuracy with which the survey can be performed. Previous studies conducted at ERIM indicated that multi-spectral scanner data might be of substantial value for this purpose [10,11]. This past experience concentrated on the use of multispectral scanner data for indicating some characteristics of individual soils and for delineating boundaries of individual soil mapping units. In soil surveys, use of this capability as a complement to aerial photography, which is already in operational use, would increase both the accuracy and efficiency with which field survey teams can select and check ground samples. These concepts of scanner data application were discussed with the USDA Soil Conservation Service (SCS) and the Michigan Agricultural Experiment Station (MSU), and it was agreed that the preliminary studies had reached a stage of development where their operational value should be applied under the practical conditions of an ongoing soil survey. An appropriate opportunity for this operational application was the National Cooperative Soil Survey begun in Jackson County in the fall of 1973. Cooperating agencies in this survey include state, county, city, and township units with the Soil Conservation Service acting as the principal mapping agency. Participation in this survey would illustrate the capability of processed scanner imagery for delineating soil types and enable us to analyze the cost-effectiveness of the technique in operational soil surveys. Such information would provide the basis for planning possible future applications of remote sensing in soil survey work in Michigan.

Operational application of multispectral imagery for soil survey was undertaken in cooperation with the USDA Soil Conservation Service

and the Michigan Agricultural Experiment Station. Mr. Thomas W. Wagner, Assistant Research Geomorphologist at ERIM, Mr. Robert Engel, Party Chief of the Jackson County Cooperative Soil Survey, and Dr. Delbert Mokma of the Crops and Soils Department, Michigan State University cooperated in the field survey operations and subsequent assessment of results. The following subsections summarize the procedures and results of this application. These are fully documented in Reference 12.

5.1 DATA COLLECTION

Jackson County is in the south-central part of the Lower Peninsula of Michigan. The county is located in a region of rolling uplands and broad, undulating stream valleys. The eastern half of the county has many lakes, wetlands, and low hills. The western part of the county is undulating and has a better integrated natural drainage system. General agriculture is the major economic activity of the county.

Most of the soils are derived from a complex distribution of outwash plains and calcareous tills. Organic soils are common in poorly drained depressions and alluvial soils occupy the narrow floodplain of the Grand River, which flows north out of the county. A soil map of the county was first published in 1926. A resurvey to meet the USDA standards for a National Cooperative Soil Survey was begun in 1973. The field mapping is expected to take five years to complete.

Multispectral and photographic data were collected on 3 April and 10 April 1974, from an east-west flightline across the northern portion of Jackson County. These data were collected at a flight altitude of about 2,400 m., rendering a photographic scale of approximately 1:15,840 and a multispectral image resolution of 7.2 by 7.2 m.

The early spring date for aerial data collection was based on a conclusion reached in a previous study that variations in natural drainage and slope were best observed for vegetated areas in the leaf-off condition. The imagery showed the terrain prior to extensive spring cultivation, so that little direct information concerning the distribution of soils within stubble covered fields could be expected. A later date for data collection (May or June) would, therefore, be preferable for areas which are predominantly agricultural.

Panchromatic photography on 9 inch (23 cm.) film and 10 bands of multispectral imagery ranging from 0.33 μm to 11.41 μm were obtained on 3 April. The flightline transected the townships of Waterloo, Henrietta, Rives, and Tompkins. Coverage of 48 sections, 12 in each township, was obtained. The second data collection mission, on 10 April, obtained 9 inch color photography and 11 bands of multispectral data (over the same spectral range) from the eastern portion of Jackson County. Data from this mission extended west from the Washtenaw County line, across Waterloo Township and into Henrietta Township. This flightline was slightly south of the 3 April flightline.

5.2 DATA PROCESSING AND APPLICATIONS

Because greater coverage of Jackson County was obtained on the first mission, multispectral data from this mission were used for image processing and field evaluation. Also, 9 inch prints of the photography were supplied to the SCS field party in July 1974 for their assessment in field mapping.

The multispectral data covered a swath 4.8 km wide and 45 km long for 3 April. The 3 April multispectral data were processed at a real time rate using standard analog techniques on a special purpose processor (the ERIM Spectral Analysis and Recognition Computer).

Four types of multispectral images were evaluated -- single band images, contrast-stretched images, two-band ratio images, and level-sliced images. Two approaches were taken in the evaluation of these images. One approach was to note distinctive features in the imagery, then locate and identify these areas on the aerial photography and on the ground. The other approach was to enlarge these 70 mm images to a size directly comparable with the 1:15,840 field mapping sheet, and then to use these enlargements in soil mapping in the field. Six of the most distinctive images were enlarged and used under actual soil survey conditions and procedures. Wagner and Mokma spent a period of two weeks in both general reconnaissance and detailed soil mapping using these images.

Section 24 and the adjacent portion of Section 23, Waterloc Township, was chosen as one test location. Approximately 80 percent of the 320 hectare site was either heavily wooded or marsh and swamp.

Figure 5 shows a panchromatic photograph of the site on 3 April. When viewed in stereo with the adjacent overlapping image, darkly mottled areas in Section 24 are seen to occupy a level lowland and the light toned field patterns in the left and lower right occur on undulating uplands. The upper right part of Section 24 is thickly wooded and the eastern part is a large cattail and sedge marsh. Much of this land is a State-owned game area.

The ERIM-collected April photography provided greater detail concerning drainage and slope than the June 1957 field sheet being used by SCS, but required greater skill to interpret. The June SCS photograph is easy to interpret, but had less terrain information than the April photograph. The value of aerial photography in the leaf-off condition depends on the extent of wetlands and woodlands to be surveyed.

The ERIM-collected color photography was only slightly easier to interpret than black-and-white photography for the same time of



FIGURE 5. PANCHROMATIC AERIAL PHOTOGRAPH OF DETAILED SOIL SURVEY SITE IN JACKSON COUNTY
Scale 1:15,800. 3 April 1974.

year and provided no additional information. The extra cost involved in collecting and printing color photographs is probably not justified for soil survey purposes.

Primary emphasis of this work was on evaluating the utility of multispectral imagery as a complement to the aerial photography already used in soil survey activities. This operational task demonstrated that useful soils information was provided by the thermal infrared data. The thermal infrared imagery clearly showed the distribution of organic and mineral soils. This information was not evident in the aerial photography obtained during the same flight.

Other bands of the multispectral imagery were also useful as a complement to the aerial photography, but the lack of detail and slightly skewed image geometry limited their usefulness. Level-sliced images provided accurate identification and area determination of surface water, green vegetation (conifers and winter wheat), woodlands and brush, roads and buildings, and bare surfaces. However, because of the temporal nature of much of this additional information, it did not contribute greatly to the process of detailed soil survey.

5.3 OPERATIONAL EVALUATION OF THERMAL IMAGERY

Since the thermal bands of multispectral imagery were found to contain the most useful information for soil survey purposes, this subsection discusses some details of the use of these bands.

Figure 6 is an annotated thermal image of the test location. This image shows contrasts related to surface temperature, cooler areas appearing darker in tone than warmer areas. At the time and date of data collection, the contrasts were influenced by vegetative cover and moisture conditions. The dark (cool) areas are either poorly-drained organic or bare mineral surfaces. Most of the soils were probably at or near field moisture capacity due to an unusually wet spring.

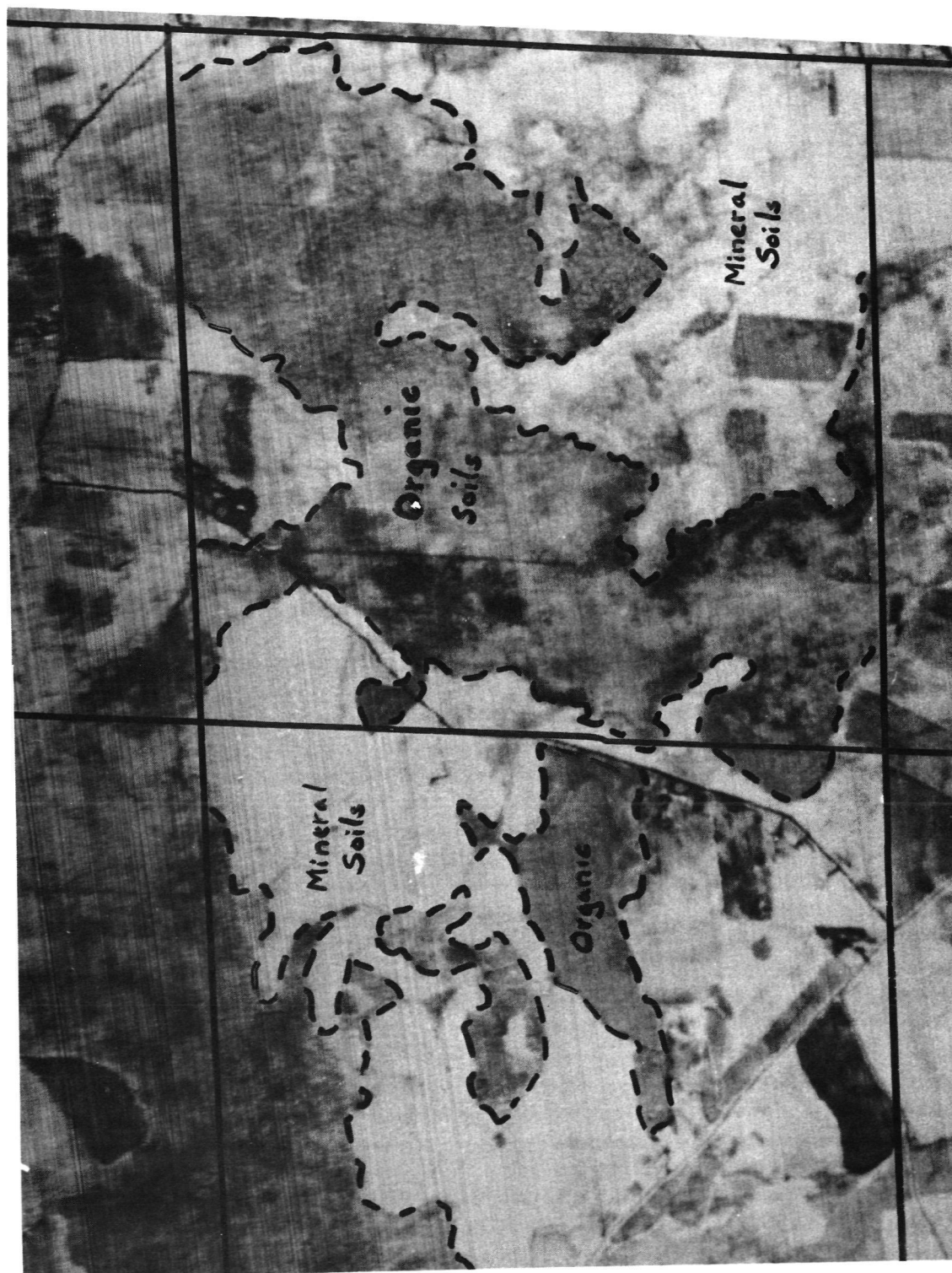


FIGURE 6. DELINEATION OF ORGANIC AND MINERAL SOILS ON A THERMAL INFRARED IMAGE
Scale approximately 1:15,400. 3 April 1974.

This image provides accurate differentiation of organic and mineral soils. The organic soil series, Houghton, Adrian, and Palms, are poorly drained; but the mineral soils range from well-drained to poorly-drained. Note that the occurrence of vegetation seems to have little influence on the image contrasts. Cattail marsh and conifer woods on Houghton muck appear equally dark (cool) while willows on a poorly-drained mineral soil mapping unit, Colwood-Lamson Complex, are as warm as field stubble over Oshtemo loamy sand. Surface drainage patterns are indicated by the darker linear tones within both the organic and the mineral areas. One exception is apparent in the distinction between organic and mineral areas; bare or partially bare mineral surfaces appear quite cool, similar to the organic areas. These are seen as dark rectangular fields within the light (warm) mineral soil areas. This misidentification can be corrected by referring to an image obtained from the ratio of the two thermal bands (Figure 7).

In this figure, the ratio of the two thermal infrared bands $\frac{(8.2-9.4 \mu\text{m})}{(9.0-11.4 \mu\text{m})}$ shows areas of bare mineral soils by their dark appearance. All other areas are uniformly light toned. Bare mineral surfaces include gravel roads, disturbed areas (as in landscaping for a new house), or bare plowed fields. A level-sliced image of the two-band thermal ratio provided precise delineation of these bare mineral surfaces (not shown). Only a small portion of the area was bare soil on the date of data collection.

The thermal infrared image was the only multispectral image that contributed significantly to soil mapping in the field. The image complemented the panchromatic aerial photograph traditionally used by SCS. However, geometric distortions in the imagery prevented precise locational reference to the field sheet, even though the imagery had been enlarged to a roughly comparable 1:15,840 scale.

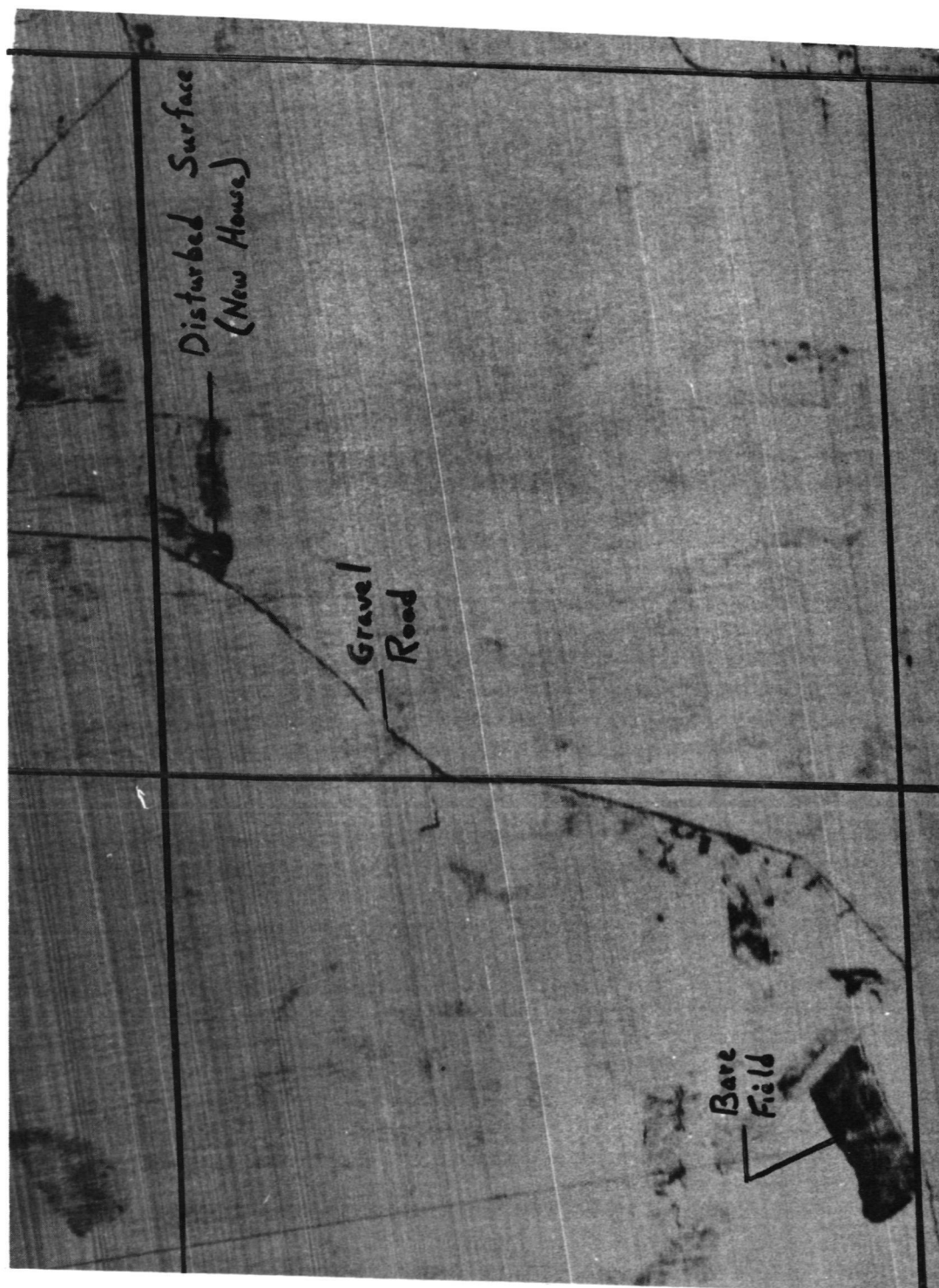


FIGURE 7. ENHANCEMENT OF AREAS OF BARE MINERAL SURFACES (DARK TONE) ON MULTISPECTRAL IMAGE. Scale approximately 1:15,400. 3 April 1974.

5.4 PROGRAM CONTINUATION

The primary contribution of scanner imagery to soil surveys lies in the thermal infrared imagery. Operational survey work demonstrated the ability of temperature differences to delineate the distribution of organic and mineral soils. It is probably feasible to provide additional information on soil texture by ratio-processing of thermal imagery in two adjacent bands. This information could best be obtained from a two-band thermal infrared scanner carried by the same aircraft used for collection of SCS aerial photography. Data collected in the spring, April or May, provides the best terrain conditions for collecting soil survey imagery. By combining two sensors on the same flight, the incremental cost of collecting thermal infrared data would be modest.

Currently, the conclusions reached from this operational application are being discussed with the staff of the Soil Conservation Service and the Michigan Agricultural Experiment Station (see Appendix A). The basic question is whether the added information provided by the thermal infrared data justifies its inclusion in operational soil surveys. Further evaluation of these and similar data may be required before the data collection and interpretation are considered operational.

Further studies are also needed to better determine the nature of the emissivity effects related to soil moisture and soil texture in the 8.0 to 9.5 μm range. There is a need for basic information concerning the behavior of mineral soils in this thermal infrared band. If the nature of the emissivity effects can be consistently identified, ratioed thermal IR images will be better able to provide useful and unique information from bare soil surfaces.

APPENDIX A
SUPPLEMENTARY INFORMATION ON REMOTE SENSING APPLICATIONS

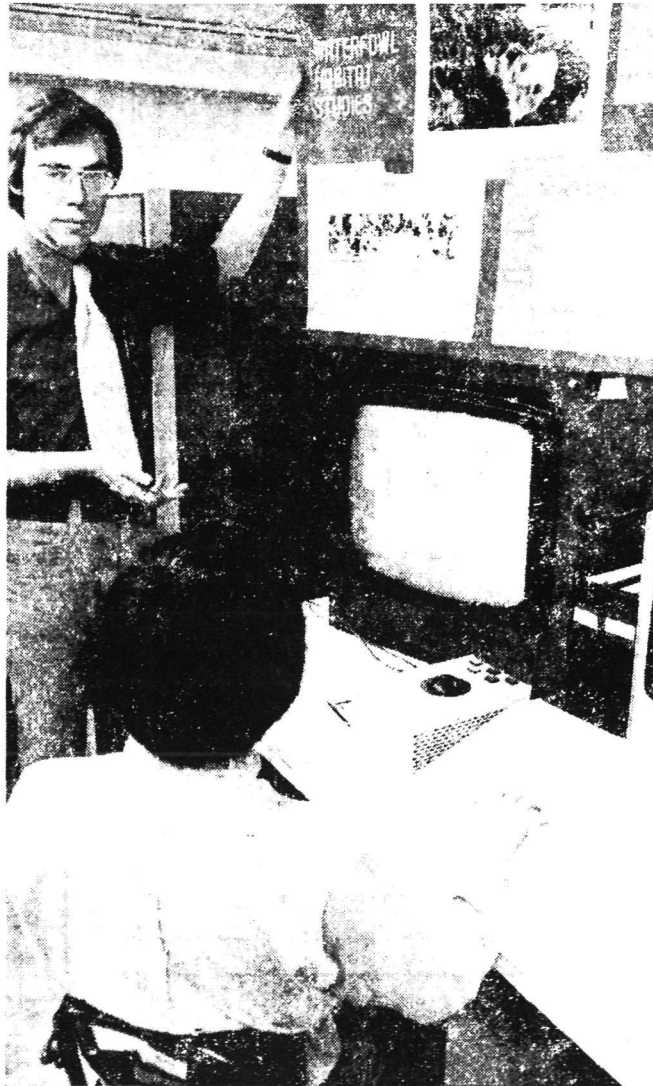
This appendix contains a number of letters and newspaper articles that supplement the discussions of individual program areas in the main body of this report.

Two newspaper articles, one from the Ypsilanti Press, the other from the Detroit News, discuss possibilities for the use of satellite imagery in statewide wetlands mapping (see Section 3.4.5).

A set of letters from the three regional commissions of the Upper Peninsula provides additional detail beyond that presented in Section 4 concerning applications of remote sensing.

Also included is a letter to Tom Wagner from R.F. Harner, State Soil Scientist with the Soil Conservation Service, indicating plans to continue the evaluation of remote sensing methods for operational soil survey discussed in Section 5.

CAMERA/*satellite aids researchers*



(Press Photo)

ERTS—Norm Roller, standing, shows the computer and TV screen that will analyze information gathered by the ERTS satellite. It will someday allow scientists to more efficiently manage the state's vanishing wetlands. In foreground is Vern Smith, a computer programmer designing the new computer that will do the job of analyzing hundreds of square miles of land in a matter of minutes.

Every 18 days for almost the past two years something has been taking your picture. But you probably didn't know it or see it because the "camera" was 569 miles (910.4 km) above you.

The photographer is named "ERTS", short for Earth Resources Technology Satellite, launched by NASA in July, 1972. ERTS takes electronic pictures using a complicated multi-spectral scanning technique of the entire earth during the course of its polar orbit.

Every 18 days it flies over the Ypsilanti-area and snaps our picture too.

But don't worry about remembering to say cheese. Objects only one acre (0.4047 hectare) and larger are visible.

It's data is available to any country in the world, but some of it's most picturesque shots are sent back to Ypsilanti's Willow Run Airport, where the Environmental Research Institute of Michigan (ERIM) hopes to someday use them in saving a rapidly deteriorating natural resource — this nation's wetlands.

With the quality of air and water and preservation of mineral resources in the forefront of the environmental movement, things such as marshes, swamps, bogs, ponds, and coastal areas have generally been ignored. But the areas are recognized to be some of the most productive biological areas in the world. They are important to the reproduction and survival of all wildlife, especially birds and migratory waterfowl.

Particularly concerned about Michigan's wetlands, which are shrinking as rapidly as any state's, is ERIM research associate Norm Roller. Roller is a forestry biologist working in the ERIM Resources and Technology lab. He sees ERTS' remote sensing techniques as a key development towards managing and preserving wetlands.

"The last survey of wetlands in Michigan and the entire country was done in 1955 using aerial photography and a sampling technique. But ERTS will give us the total picture, so we can get more information a lot quicker and more efficiently," Roller said. More

importantly, he said, it will allow the time that would have been spent gathering the data to be spent analyzing it and putting the information to use.

Pictures in Roller's Willow Run lab point out the problem of wetlands located at the mouth of the Huron River and near Lake St. Clair. They show the extent of erosion and the loss of natural habitats for animals and birds. What's causing the loss of wetlands? Both man and nature are to blame Roller says.

"There've been cyclical changes such as higher lake levels and more early spring storms causing wave erosion. But man too is responsible. Man made structures are altering the environment, such as urban development, more highways, parking lots, and things such as building a new canal in Chicago and more water through the Michigan locks at the Soo," he explained.

But loss of wetlands isn't the only problem. There are the dangers of flooding too. A picture of St. John's marsh, near Lake St. Clair, shows a golf course in 1938. The course is under water now, area sewers are backing up into the bay and basements are full of water.

"On the bright side it shows that wetlands can be returned to their natural state. But it also shows we have to know how to manage them," he said.

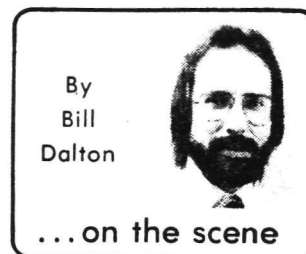
Roller said the state Department of Natural Resources is considering purchasing the marsh to develop a new concept in parks. It would have both the elements of a recreational area and a wildlife preserve.

"These areas are important to preserve especially since this area is in the Mississippi flyway for migratory waterfowl," he said.

How does the ERTS satellite fit in? Up for consideration in the state now is House Bill 4618 proposing a survey of Michigan for the regulation and development of the state's wetlands, to provide an inventory for their protection and management.

"The DNR and ERIM are convinced such a study will be forthcoming and I think utilizing ERTS would be the best way to do it," Roller said.

ERTS would take the pictures of the state, providing uniform data that will be analyzed by a special computer also being built at ERIM.



The computer will analyze the state, township by township, showing water, wetlands, marshes, forests and various types of vegetation.

The information will be fed through the computer which will locate by longitude and latitude each wetland, and indicate its size and particular classification (river, marsh, bog, etc.) Once the analysis is completed, Roller believes a resource manager will be able to sit down to the computer and project on the accompanying TV screen the areas to "manage". The person would be able to devise the optimal configuration of wetlands, woodlots, forests and urban and rural areas, to hopefully later be put into practice.

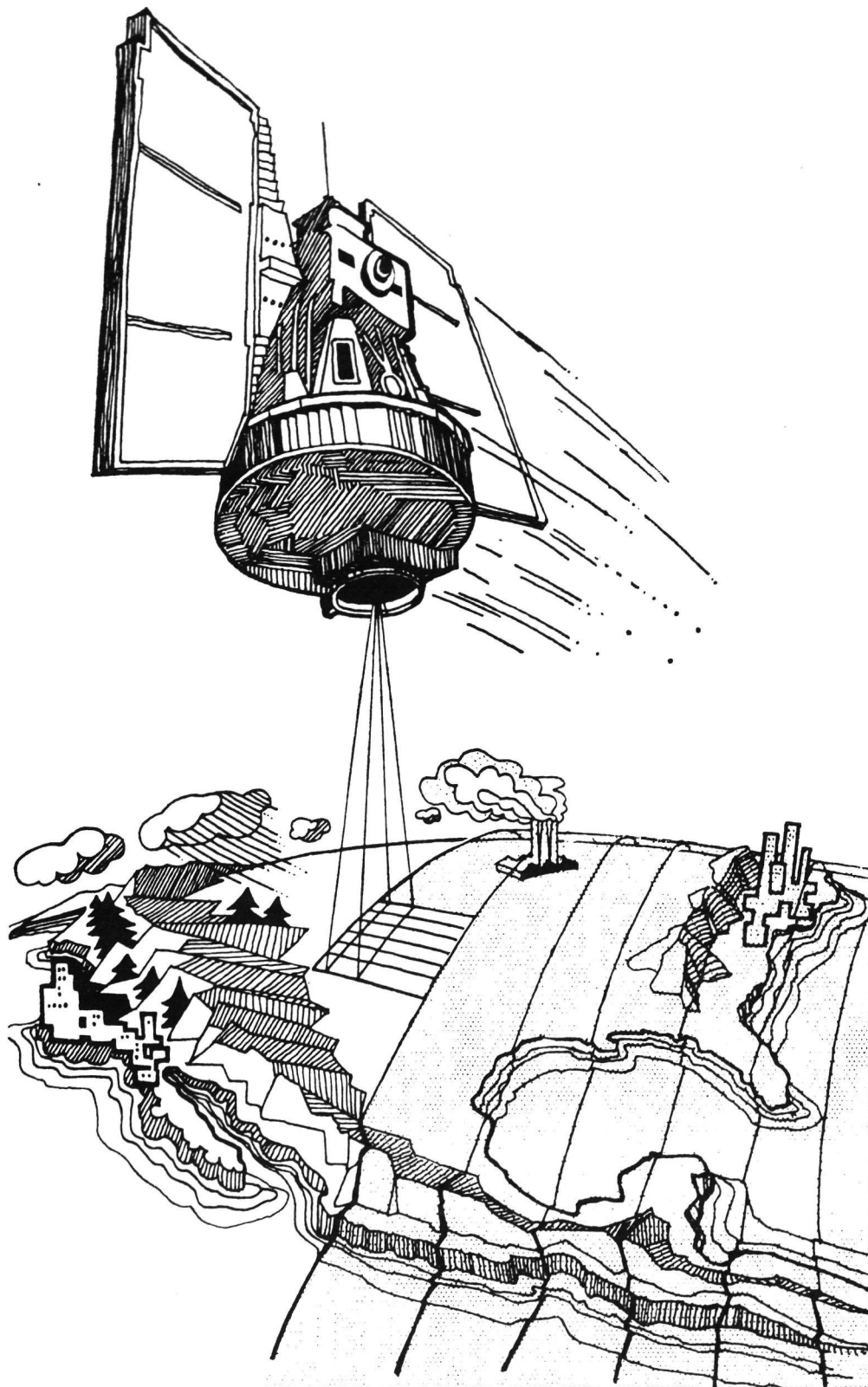
"Hopefully we'll be able to develop the proper habitats for wildlife, comprehensive resource management," he said. One example he cited was a study of ponds in N. Dakota utilizing ERTS photos. The more ponds ERTS saw in the spring, the more ducks there were in the fall, which makes some sense.

"But knowing there are more ponds on a statewide basis is only possible with ERTS and possible more efficiently. The state was able to raise and lower bag limits on the wildlife and more effectively manage them," he said.

Using ERTS to survey wetlands he says will not only "tell us where we are now, and what we've already lost," but will provide valuable historical information to be used in the future to preserve existing wetlands.

The future for "remote sensing" with satellites includes photos and analysis of areas smaller than a baseball field by the 1980's.

"Someday you might be able to get a satellite picture of your own backyard if you wanted it," Roller said.



Eye in sky

State hopes to use satellite data to cut loss of valuable wetlands

By JAMES L. KERWIN
News Staff Writer

Michigan will use a satellite hurtling 500 miles over the state to help set up a program to save its dwindling wetlands from further destruction.

At present, state officials do not know just how much valuable acreage remains in marshes, bogs and swamps.

But they are concerned that there has been too much filling of wetlands in recent years for farming and for urban development such as housing, highways, shopping centers and recreational areas.

Much of that development has centered in southeastern Michigan, especially the Detroit metropolitan area.

"We've lost huge chunks of productive wetland that have been drained and filled by developers," said Ed Mikula, a specialist in the wetland wildlife division of the Department of Natural Resources (DNR).

Marshes provide habitat for animals and waterfowl, as well as spawning and feeding grounds for fish.

Also, some areas have been a feeding area for such upland game as pheasants, quail and deer.

"All those cattails and mosquito infested marshes may look worthless to some, but they are valuable for our fish and wildlife population," said Mikula.

But before the program to stop further filling can get under way, the state must inventory what's left.

That's where the satellite comes in.

Since July, 1973, Michigan — along with other parts of the world — has been undergoing the scrutiny of an Earth Resources Technology Satellite (ERTS) on a polar orbit.

It not only stores data that can be fed into computers, but uses an electronic sensor similar to a camera that provides a look at what is on the ground down to an area of an acre.

"It works beautiful on wetlands . . . they show up very dark, and you can tell wooded areas, and the depth of the water by the shade," reports Norm Roller, who is a research associate at the Environmental Research Institute.

The institute, located at Willow Run Airport, does work for National Aeronautics and Space Administration, which put up the satellite.

Although it was expected to last only a year, the ERTS scanner still provides data, passing over the Detroit area every 18 days, even though a second one — called Land Satellite II — is now in use.

Roller expects to begin the wetland inventory survey for the DNR from data already stored in a computer center.

The data would be compared with aerial photos of the state taken in the 1930's and 1950's.

Otherwise, state officials would face the tedious task of ground surveys, making only a random sampling of areas and then estimating the amount and types of wetlands.

Roller said using the satellite permits a "more comprehensive look at the total resources," which then can be detailed by using airplanes "once we know what is there."

His agency already is using the same method in surveying the St. John Marsh along Anchor Bay on Lake St. Clair, which the state is seeking to purchase and preserve.

A wetlands management and protection bill was introduced in the State Legislature recently by State Rep. Warren Goemaere, D-Roseville.

The measure, which has 57 co-sponsors, seeks to pinpoint areas to be preserved.

It would tightly control future development and prohibit dumping or removal of material in wetlands, eventually even restricting expansion of agriculture and road recreational vehicle usage.

But before anything can be done, officials said they need to know what remains — with the satellite becoming an indispensable tool to finding out.

CUPPAD

CENTRAL UPPER PENINSULA PLANNING AND DEVELOPMENT REGION
2415 14th Avenue South Escanaba, Michigan 49829
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Chief Planner
Civil Engineer

George W. Rusch
D. Gregory Main
Amos Roos

November 27, 1974

1.9432.1

The Honorable Philip E. Ruppe
U.S. Representative
203 Cannon Office Building
Washington, D.C. 20515

Dear Phil:

We have recently received some high altitude imagery of parts of the Central Upper Peninsula. The imagery, which consists of black and white, color and color infra-red photographs, was obtained from NASA through the Environmental Research Institute of Michigan.

It is being used to assist us in identifying land uses and other features necessary to the preparation of plans and management programs at both the regional and local level.

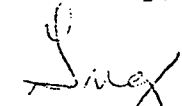
We are also making an attempt to acquaint other potential users, such as foresters and agricultural interests with the potential value of this material. Since the photography is on file in our office, it will be accessible to other users as well.

As mentioned above, the Environmental Research Institute of Michigan coordinated the project working with Dr. Joseph Vitale of the Office of University Affairs, NASA Headquarters, Washington. The mission was flown in July of this year, by personnel from NASA Ames Research Center at Moffatt Field, California.

The other two regions in the Upper Peninsula have also received coverage for parts of their jurisdictions.

I thought you would be interested in knowing that the Upper Peninsula is benefiting from modern technology available from NASA. If you have any questions or wish additional information, please don't hesitate to contact us.

Sincerely,



D. Gregory Main
Chief Planner

DGM:pm

"Some men see things as they are and say WHY,
we dream things that never were and say WHY NOT."
— George Bernard Shaw



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Executive Director	George W. Rusch
Chief Planner	D. Gregory Main
Civil Engineer	Amos Roos

December 31, 1974

1.9625

Mr. Buzz Sellman
Assistant Research Geographer
Environmental Research Institute
of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107

Dear Buzz:

This letter relates some of the benefits derived from use of the high altitude imagery collected by NASA in July 1974.

As you know, CUPPAD is a six-county regional planning and development commission responsible for comprehensive and functional planning and development in the Central Upper Peninsula. A substantial part of our work program is devoted to assisting local governments with planning and management activities. Among other things, we maintain an extensive data bank and conduct an extensive mapping program.

The following items describe benefits derived during the three months which we have had the imagery in our offices.

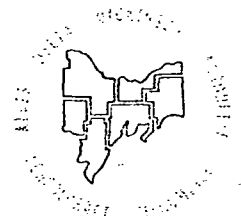
1. Chocolay Township Land Use Inventory.

The Chocolay Township Planning Commission is in the process of preparing a comprehensive plan and zoning ordinance. Rapid growth is quickly eroding the land resources of the Township and the Commission was vitally interested in obtaining an accurate mapped inventory of active and inactive farmlands. These areas were quickly identified using the imagery and then verified in the field. Estimated time savings amounted to two man-days.

2. Ford Airport Zoning.

The imagery was used to update existing maps (relocated roads, etc.) to produce an accurate map for zoning purposes.

*"Some men see things as they are and say WHY,
we dream things that never were and say WHY NOT."*
— George Bernard Shaw



Mr. Buzz Sellman
December 31, 1974
Page Two

3. Coastal Zone Management Planning.

CUPPAD is under contract with the Michigan DNR to prepare a plan for use of the Great Lakes shorelands. As part of this effort, we have used the imagery to help identify shoreland features, both natural and man-made. Given the extensive amount of shoreline and the limited funds and time available to complete the work, the imagery greatly increased the level of detail which we could inventory.

In addition, there were no accurate maps of the shorelands and the imagery was used to construct maps. Total savings amounted to at least one man-month for this program.

4. Industrial Site Location Study.

We were approached by a local industry to assist in locating a new site for their industry. Utilizing criteria provided by the firm, we quickly identified those areas meeting the soils, and accessibility criteria and used the imagery to identify vacant lands meeting the size criteria. This information is currently being used by the industry to acquire lands.

In conclusion, let me point out that our jurisdiction consists of more than 8,000 square miles. The imagery has already improved the capabilities of this organization in meeting our commitments to local government. I am confident that even greater use will be made of this resource in the next few months.

Sincerely,



D. Gregory Main
Chief Planner

DGM:pm

CUPPAD

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T. Reque, Schoolcraft

Executive Director
Chief Planner
Civil Engineer

George W. Rusch
D. Gregory Main
Amos Roos

May 9, 1975

OPD 174-6

Mr. Buzz Sellman
Assistant Research Geographer
Environmental Research Institute
of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107

Dear Buzz:

Congratulations on your new job! Be sure and let me know how to get in touch when you get established. For our part, the U-2 coverage is becoming increasingly useful both for our operations as well as other groups in the area. The following is a brief discussion of activities involving the use of the imagery:

1. Coastal Zone Management

The imagery was used in the inventory process to identify shoreline types; special environments, such as wetlands; in distinguishing vegetative types including forests and agriculture; and man-made features including development density.

2. Menominee Township Comprehensive Planning

We are assisting this rapidly urbanizing Township in the preparation of a comprehensive plan. The imagery provided us with the ability to complete a detailed land use inventory during the winter months when field surveys were not possible due to snow cover.

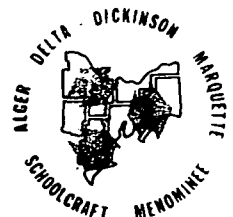
The infra-red imagery was particularly useful in determining the precise location of new development and in illustrating to citizen groups the development trends and problems.

3. Hannahville Indian Community

We assisted the Hannahville Tribal Council in the development of an application for federal assistance to establish a hog farming operation. In the process, the imagery was used to help select areas for pasture, the associated building, and feed crop lands.

*"Some men see things as they are and say WHY,
we dream things that never were and say WHY NOT."*

— George Bernard Shaw



Mr. Buzz Sellman

May 9, 1975

Page Two

4. Manistique Industrial Site

We are assisting the City of Manistique in selecting an industrial park site. The imagery is being used in the required environmental assessment process to select the site with the least environmental impact and lowest overall site development cost.

I trust these examples illustrate the value of the imagery to our operation.

As I mentioned earlier, other agencies are beginning to make use of the imagery as well. We recently obtained duplicates for two counties and one city. In addition, we have recently received an inquiry from a major power company which may also be interested in use of the imagery.

Should there be any questions, please contact me; and again, best wishes in your new job.

Sincerely,

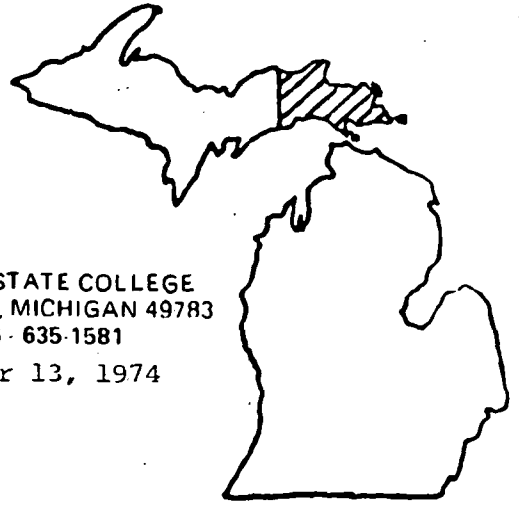


D. Gregory Main
Chief Planner

DGM/bmr



EASTERN U. P. REGIONAL PLANNING & DEVELOPMENT COMMISSION



EXECUTIVE DIRECTOR
JOHN W. CAMPBELL

LAKE SUPERIOR STATE COLLEGE
SAULT STE. MARIE, MICHIGAN 49783
PHONE 906-635-1581

December 13, 1974

Mr. Buzz Sellman
Associate Research Geographer
Research Institute of Michigan
P. O. Box 618
Ann Arbor, Michigan 48107

Dear Mr. Sellman:

Much local interest has been generated in these aerial photographs. People are mainly interested in them because they are the most current records available. Tax assessors are interested in them for updating the regional system of trails to reach back country acreage. Appraisers are interested in them for acreage measurements.

One application that has evolved through our office was by Mr. Paul C. Rugen. Mr. Rugen is a Fishery Biologist working for the U. S. Department of the Interior, Bureau of Sport Fisheries and Wildlife in the Sea Lamprey Control Program.

Since these photos are current, he used them to find out what happened to a dose of lamprey poison that was lost. After the poison was dumped in the Carp River, Mackinac County in the vicinity of East Lake, the downstream monitor did not record any poison. After using the photos, Mr. Rugen determined that the area between the release point and the monitoring station was extensively dammed by beavers.

Mr. Rugen also used the photographs to find a new logging road into the headwaters of Beavertail Creek in eastern Mackinac County. He plans to use this new road for access in his poisoning program.

The Regional Planning Commission used the information on the photos to decide the network of a regional snowmobile trails system in the Eastern U. P. Region.

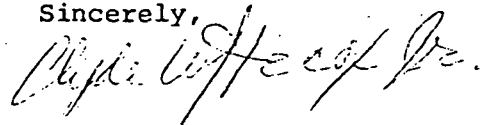
Several local township zoning commissions used the photos to decide what the current extent of zoning should be to provide protection

for agricultural land. These commissions also found the photos valuable in deciding the extent of zoning to provide protection from extensive development near wetlands.

Our office has had the use of this imagery for only a few months and in this short time has been most useful to local decision makers. (Township Boards, County Boards and City Commissions) The one area in which this photography has been most useful has been in land use planning. Without it, many months of work would be required to obtain the same information we can get from the photos in a few hours.

Therefore, we strongly recommend the continuation and expansion of this high altitude photography program to provide us with complete coverage of our entire region on a yearly basis so that all units of government can benefit and utilize the imagery in their decision making process.

Sincerely,

A handwritten signature in cursive script, reading "Clyde W. Hecox, Jr.", written in dark ink.

Clyde W. Hecox, Jr.
Shorelands Planner and
Housing

CWH:bf

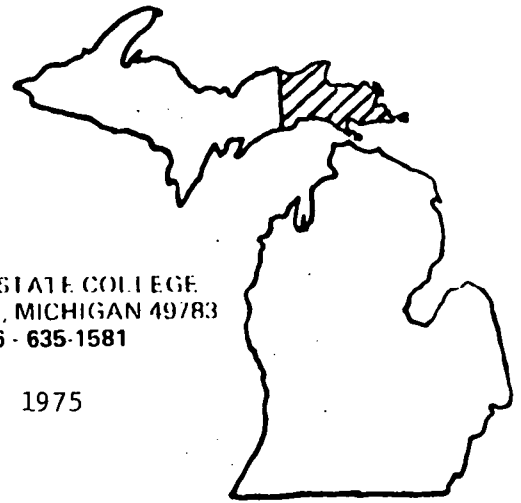


EXECUTIVE DIRECTOR
JOHN W. CAMPBELL

EASTERN U. P. REGIONAL PLANNING & DEVELOPMENT COMMISSION

LAKE SUPERIOR STATE COLLEGE
SAULT STE. MARIE, MICHIGAN 49783
PHONE 906 - 635-1581

May 12, 1975



Mr. Buzz Sellman
Environmental Research Institute
of Michigan
P. O. Box 618
Ann Arbor, Michigan 48107

Dear Buzz:

Thank you for the information on mission 103.

At present, I am engaged in mapping permanent structures along the shoreline of the Great Lakes in our region. This is being accomplished by using the low altitude photos supplied by your office. We are attempting to use the Michigan Land Use Classification system. With some ground truth collection plus the aerial photos we can reach level II and in most cases, level III.

I have ordered enlargements of the high altitude imagery (36"x 36") for coastal areas not covered by the low altitude flights. As of this time, we have not received them. I am hoping they will enable me to map shoreline development with the same accuracy as the low altitude photos.

Whitefish Township's Zoning Commission wants enlargements of their area as an aid to tax assessing and land use decision-making.

Kinross Township is developing a 125 acre fairgrounds complex and they have expressed interest in the high altitude infra-red enlargements as an aid in developing their master plan.

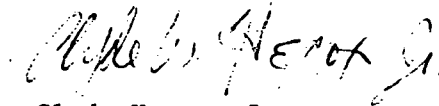
Our agency was going to investigate the possibility of a timber type and size inventory for Whitefish and Clark Townships. These are the only two Townships with complete high altitude coverage. We have decided that a pilot project for just two townships would be contrary to our role as a regional planning agency.

Mr. Buzz Sellman
Page 2
May 12, 1975

I would be most interested in coming down to visit your shop.
I am especially interested in your shoreland mapping program.

If you need further information, please feel free to contact
us.

Sincerely,

A handwritten signature in dark ink, appearing to read "Clyde Hecox, Jr.", written in a cursive style.

Clyde Hecox, Jr.
Housing and Coastal Zone
Planner

CH/pc



Western Upper Peninsula Planning & Development Region

P.O. BOX 365

HOUGHTON, MICHIGAN 49931

PHONE 906 - 482-7205

May 12, 1975

Mr. Buzz Sellman
Associate Research Geographer
Environmental Research Institute
of Michigan
P.O. Box 618
Ann Arbor, MI 48107

Dear Buzz:

The high altitude infrared and conventional photography that ERIM was able to make available to us from NASA has been becoming more useful to our agency and other interested parties as time passes. The remote sensing workshops that have been held on both an informal and formal basis have been beneficial to us in learning how to interpret and utilize this resource tool.

During the past year our agency has made use of the photography in the following ways:

1. In our Coastal Zone Management Program, we have used the photography to determine (a) generalized forest cover types, (b) categories of wetlands, (c) shoretypes, and (d) land use.

In determining forest cover types we have separated the forests in seven major associations; northern hardwoods, aspen-birch, upland conifers, lowland conifers, lowland hardwoods, hemlock and mixed.

For wetlands, we are attempting to use the State of Michigan's Standard Land Use Classification System at Level III.

In identifying shoretypes, the photography is quite useful in separating areas of beach terraces and sand dunes from areas of shallow bedrock or lacustrine clay influence. Also separated from each other are beach types. Sand beaches come out as white while beaches of mine tailings have a blue hue. In inventorying land use, we have been using combinations of Level II and III.

2. For our A-95 Review Process we are using the photography to evaluate proposed projects in terms of environmental impact. Application of the photography, in the review of a proposed marina project, resulted in the redesigning of the project, thus preserving a wetland and waterfowl feeding area.

May 12, 1975

3. In our on-going planning such as sewer/water and land use the photography is constantly being referred to.

Use of the photography by other organizations has included:

- A. The White Pine Mining Company is planning to use the photography for geological exploration of copper.
- B. The Homestake Mining Company, which is operating an exploratory mining operation in the Keweenaw Peninsula, has expressed interest in viewing the photography for determining the site for a new tailing pond as well as geologic investigation.
- C. The Ottawa National Forest is using the photography by their compartment planning (a forest management area).
- D. Universal Oil Products (UOP), a corporation which owns a quarter of a million acres in the Keweenaw Peninsula is using the photography in the design of water-related development along Lake Superior. Universal Oil Products forester has also expressed some interest in using the photography.
- E. The Forestry Department and Geology Department at Michigan Technological University are also using the photography for academic as well as research activities.
- F. Although nothing has yet been done in the area, it is expected that agricultural organizations may have some use for the photography as it shows a number of different types of cropland.

Our office has assisted many of the above mentioned groups in either ordering the photography or in using it at our offices. From where we stand, the photography has been invaluable in performing our role in the Coastal Zone Management Program.

Future needs that we would have for photography would be in selected areas of wetlands, other environmental areas, and agricultural areas that weren't covered in last summer's flight.

We would like to take this opportunity to thank NASA and ERIM for arranging for the flying of our Region last summer. The information filled a very large gap.

Thankfully,



David K. Stewart,
Associate Planner

DKS/ski

Enclosure

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE Room 101, 1405 South Harrison Road
East Lansing, Michigan 48823

August 4, 1975

Mr. Tom Wagner
P.O. Box 618
Ann Arbor, Michigan 48103

Dear Tom,

I have received the copy of "A Continuing Study of the Application of Multispectral Imagery to Soil Surveys", dated June 1975. I greatly appreciate getting this copy and also the copy of the report and imagery you furnished Robert Engel.

After the survey party in Jackson County works on the soil survey of the study area, they will have a better evaluation of the usefulness of the imagery. We plan to make maximum use of the information as a further effort in relating various kinds of imagery to making soil maps. We expect to shortly have panchromatic photography taken in April 1974 to use in mapping. This will give us another comparison with the imagery you obtained in the same month.

Thanks again for the contribution you have made. We will continue to use the materials and information and keep in touch with you as work progresses.

Sincerely,

Rod Harner

Rodney F. Harner
State Soil Scientist

cc: Robert Ditson, Area Conservationist, SCS, Ann Arbor, Michigan
Robert Engel, Party Leader, SCS, Jackson, Michigan



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ATTN: Mr. J.A. Vitale, Code PY (10)